

THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS

Subs A2
1. A method of transmitting real time signals as digital data packets over a communications network, the method comprising:

5 providing first and second time stamps in each packet of a real time signal required to be transmitted, said first time stamp indicating the elapsed time of the real time information represented by the data carried in the packet and said second time stamp indicating a time at which assembly of the packet at a source had occurred, and wherein said time stamps are derived from a universal time measure available to the source, a destination and routing points in the network whereby, in use, timely transfer en route and time-faithful reconstruction of the real time signal at the destination is possible.

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15 2. A method of transmitting real time signals as defined in claim 1, wherein said first and second time stamps are provided in the form of binary integers in a header extension containing fields for said first and second time stamps.

Subs A2
3. A method of transmitting real time signals as defined in claim 2, wherein said header extension further includes a field indicating that the packet is on a real time connection and a field indicating whether a packet is at the start of a real time episode or a continuation of a real time episode.

20 4. A method of transmitting real time signals as defined in claim 2, wherein an adopted time unit for measurement of time employed in said first and second time stamps is related to a reference frequency locked to said universal time measure by a multiplying constant derived from a power of 2, whereby said adopted time unit is small enough not to require subdivision for most foreseeable measurements of communications timeliness.

25 5. A method of transmitting real time signals as defined in claim 4, wherein information identifying the frequency of said reference oscillator at the

- 24 -

Suds A2

source and the power of the multiplying constant is included in the header extension so that said adopted unit of time is recoverable at said routing points and destination.

5 6. A transmitting apparatus for transmitting real time signals at a source as digital data packets over a communications network, the transmitting apparatus comprising:

10 means for inserting first and second time stamps in each packet of a real time signal required to be transmitted at the source, said first time stamp indicating the elapsed time of the real time information represented by the data carried in the packet and said second time stamp indicating a time at which assembly of the packet at a source had occurred, and wherein said time stamps are derived from a universal time measure available to the source, a destination and routing points in the network whereby, in use, timely transfer en route and time-faithful reconstruction of the real time signal at the destination is possible.

15 7. A transmitting apparatus for transmitting real time signals as defined in claim 6, wherein said means for inserting first and second time stamps includes a header extension generating means for generating a header extension for each packet of said real time signal, said header extension containing fields for said first and second time stamps.

20 8. A transmitting apparatus for transmitting real time signals as defined in claim 7, wherein said means for inserting first and second time stamps further includes a reference time clock generating means, which includes a reference oscillator for generating a reference frequency locked to said universal time measure, a multiplier for multiplying the reference frequency by a first multiplying constant, and first and second registers for latching start and finish times respectively of the interval of time that is spanned by a segment of the real time signal represented in the payload of a given packet.

Suds A2

- 25 -

9. A transmitting apparatus for transmitting real time signals as defined in claim 8, wherein said means for inserting first and second time stamps further includes means for calculating said first and second time stamps using the latched values of said start and finish times based on an adopted time unit for measurement of time related to said reference frequency by a second multiplying constant derived from a power of 2.

10. A transmitting apparatus for transmitting real time signals as defined in claim 7, wherein said header extension generator means also generates additional fields for indicating that the packet is on a real time connection and whether the packet is at the start of a real time episode or a continuation of a real time episode in said header extension.

11. A routing apparatus for routing real time signals as digital data packets over a communications network, the routing apparatus comprising:

means for retrieving first and second time stamps from each packet of a real time signal required to be routed, said first time stamp indicating the elapsed time of the real time information represented by the data carried in the packet and said second time stamp indicating a time at which assembly of the packet at a source had commenced, and wherein said time stamps are derived from a universal time measure available to the source, a destination and routing points in the network; and,

means for supervising dispatch of each of said packets in sequence by determining a target time for latest completion of dispatch of the next succeeding packet using the first time stamp in a packet whereby, in use, successive packets are substantially always despatched ahead of, or on, scheduled time.

12. A routing apparatus for routing real time signals as defined in claim 11, further comprising:

means for imposing an enforced wait in the timing of dispatch of a first packet by a predetermined time interval selected to be short enough to

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- 26 -

introduce an acceptable contribution by a routing apparatus to the total delay of the real time signal and long enough to provide sufficient time margins for the timely dispatch of subsequent packets.

5 13. A routing apparatus for routing real time signals as defined in claim 12, further comprising:

means for confirming that a packet is the next successive packet in sequence of the real time signal by comparing its first time stamp with a combination of the first and second time stamps of the previous packet.

10 14. A routing apparatus for routing real time signals as defined in claim 12, wherein said means for imposing an enforced wait includes an enforced wait unit having a timer for generating said predetermined time interval, and memory means for temporarily storing the first and second time stamps of the first packet in a WAIT queue for the duration of said predetermined time interval prior to transfer to another queue ready for dispatch.

15 15. A routing apparatus for routing real time signals as defined in claim 14, wherein said means for supervising dispatch includes a scheduling means for determining a deadline for the start of dispatch of a packet by taking its length, an output data channel link rate and the previously determined target time for latest completion of dispatch into account, said scheduling means also determining said target time for latest completion of dispatch of the next succeeding packet.

20 16. A routing apparatus for routing real time signals as defined in claim 15, wherein said means for supervising dispatch also includes a dispatch control means for checking that all deadlines previously set by the scheduling means can still be met and initiates a dispatch of the next packet before or on the scheduled deadline for start of dispatch.

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Subs
G2

- 27 -

Subs A2

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17. A method of routing real time signals as digital data packets over a communications network, the method comprising:

retrieving first and second time stamps from each packet of a real time signal required to be routed, said first time stamp indicating the elapsed time of the real time information represented by the data carried in the packet and said second time stamp indicating a time at which assembly of the packet at a source had occurred, and wherein said time stamps are derived from a universal time measure available to the source, a destination and routing points in the network; and,

10 supervising dispatch of each of said packets in sequence by determining a target time for latest completion of dispatch of the next succeeding packet using the first time stamp in a packet whereby, in use, successive packets are substantially always despatched ahead of, or on, scheduled time.

15 18. A method of routing real time signals as defined in claim 17, further comprising the step of imposing an enforced wait in the timing of dispatch of a first packet by a predetermined time interval selected to be short enough to introduce an acceptable contribution by a routing apparatus to the total delay of the real time signal and long enough to provide sufficient time margins for the timely dispatch of subsequent packets.

20 19. A method of routing real time signals as defined in claim 18, further comprising the step of temporarily storing the first and second time stamps of the first packet in a WAIT queue for the duration of said predetermined time interval, prior to transfer to another queue ready for dispatch.

25 20. A method of routing real time signals as defined in claim 18, further comprising the step of confirming that a packet is the next successive packet in sequence of the real time signal by comparing its first time stamp with a combination of the first and second time stamps of the previous packet.

- 28 -

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21. A method of routing real time signals as defined in claim 17, wherein said step of supervising dispatch includes a step of determining a deadline for the start of dispatch of a packet by taking its length, an output data channel link rate and the previously determined target time for latest completion of dispatch into account, and determining a target time for latest completion of dispatch of the next succeeding packet.

5 22. A method of routing real time signals as defined in claim 21, wherein said step of supervising dispatch also includes checking that all deadlines previously set can still be met and initiating a dispatch of the next 10 packet before or on the scheduled deadline for start of dispatch.

10 23. A receiving apparatus for receiving real time signals at a destination as digital data packets over a communications network, the receiving apparatus comprising:

15 means for retrieving a first time stamp from a packet of a real time signal required to be presented at the destination, said first time stamp indicating the elapsed time of the real time information represented by the data carried in the packet, and wherein said first time stamp is derived from a universal time measure available to a source, the destination and routing points in the network;

20 a presentation timing clock for controlling the timing of presentation of the real time signal at the destination; and,

25 means for adjusting the presentation timing clock based on a comparison of the first time stamp with the actual time taken to present the real time information represented by the data carried in the packet whereby, in use, a timing clock at the source can be recovered to ensure time-faithful reconstruction of the real time signal at the destination.

24. A receiving apparatus for receiving real time signals as defined in claim 21, wherein said means for adjusting the presentation timing clock includes a reference clock generating means having a reference oscillator locked

- 29 -

to said universal time measure, and first and second registers for latching start and finish times respectively of the interval of time spanned by a segment of the real time signal being presented at the destination.

25. A receiving apparatus for receiving real time signals as defined in claim 22, wherein said means for adjusting further comprises means for calculating a differential time from said start and finish times and means for comparing this differential time with said first time stamp, and means for using the result of the comparison to adjust the presentation timing clock.

26. A receiving apparatus for receiving real time signals as defined in
10 claim 23, wherein said means for using the comparison to adjust the presentation
timing clock is a phase locked loop (PLL) provided in connection with a voltage
controlled oscillator (VCO) in a signal presentation unit in the receiving unit.